Cosa c'è di nuovo?

Efficacia e sicurezza della lesione e della tecnologia con punta in oro: quando, come e con quali risultati?

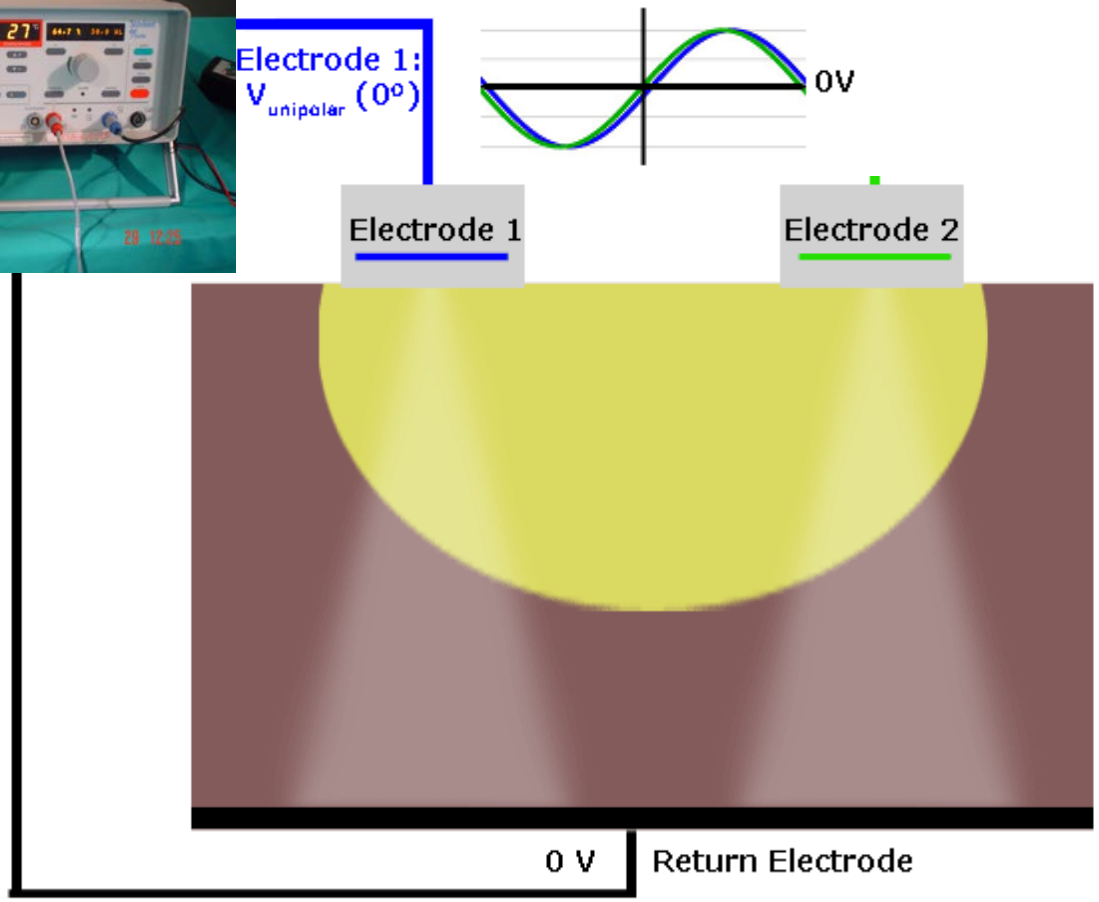
Stefano Nardi, MD, PhD

Arrhythmia, EP Center and Cardiac Pacing Unit

Cardiovascular Department

Presidio Ospedaliero "Pineta Grande" (CE)

"In-phase" energy delivered



How Does RFCA Work ?

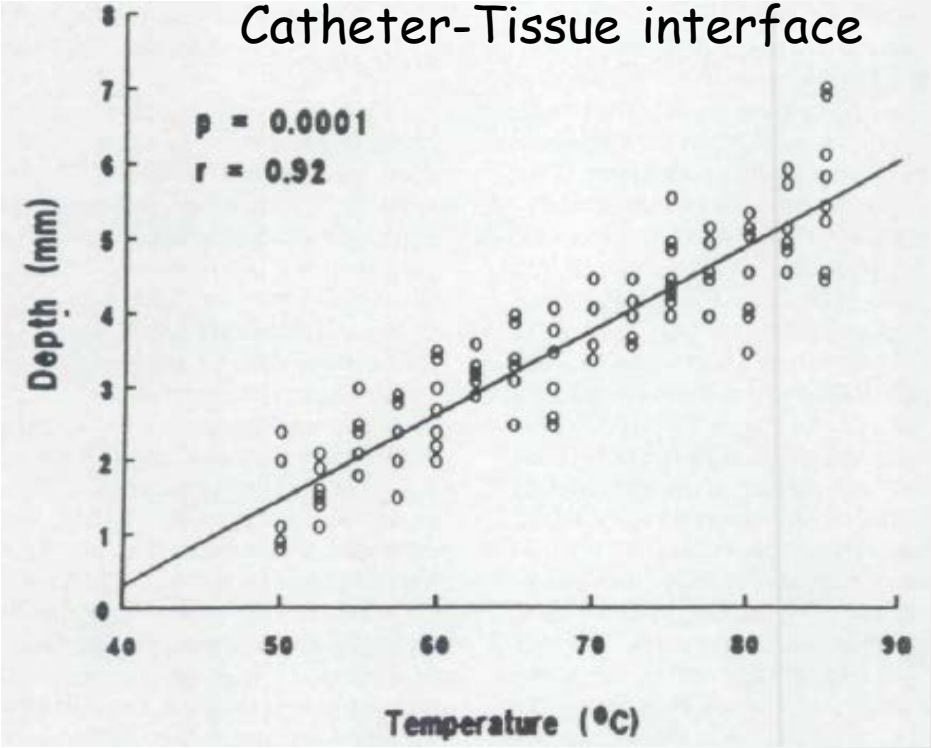
- Hemoreologic Characteristic of Blood
- Power level Selected
- Target Temperature Set-up
- Duration of the Ablation
- Active Cooling
- Contact force at the interface

The Unmet Need in RFCA

- Anatomical Properties of Tissue
- Type of Contact
  force of penetration, contact and shape of tip
- Watts and °C reached at the tip/tissue interface
- Passive Cooling

The importance of Temperature Reading

- Electrode temperature and Delivered power are both very accurate to predicted lesion size compared with the other parameters



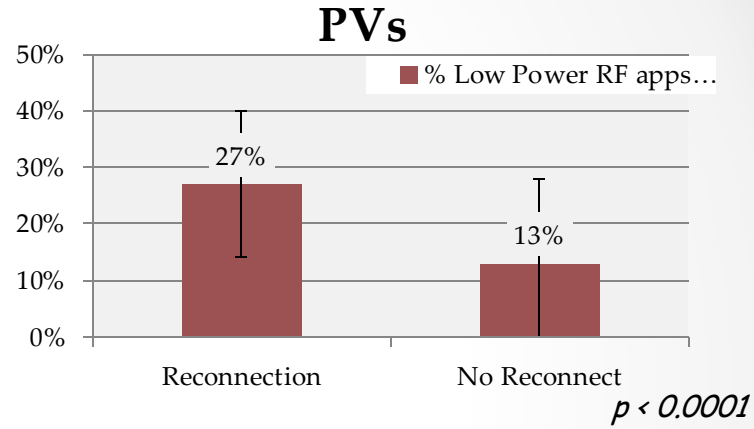
* Temperature Monitoring During Radiofrequency Ablation , H Calkins, JCVE 1996
** RF coagulation of ventricular myocardium: Improved prediction of lesion size by monitoring catheter tip temperature. Hindricks, EHJ 1989

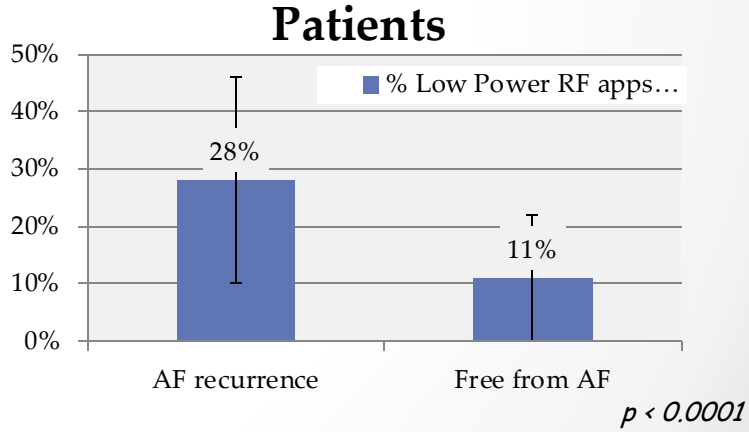
Contact Recognition

combination of Power (W) and Temp (°C) is predictive of outcomes

PVI after 1hr & Adenosine Challenge	% Low Power RF applications
Reconnection	27% ± 13%
No Reconnection	13% ± 15%

Patient Outcome @ 12 months (n=80)	% Low Power RF applications
AF recurrence	28% ± 18%
Free from AF	11% ± 11%



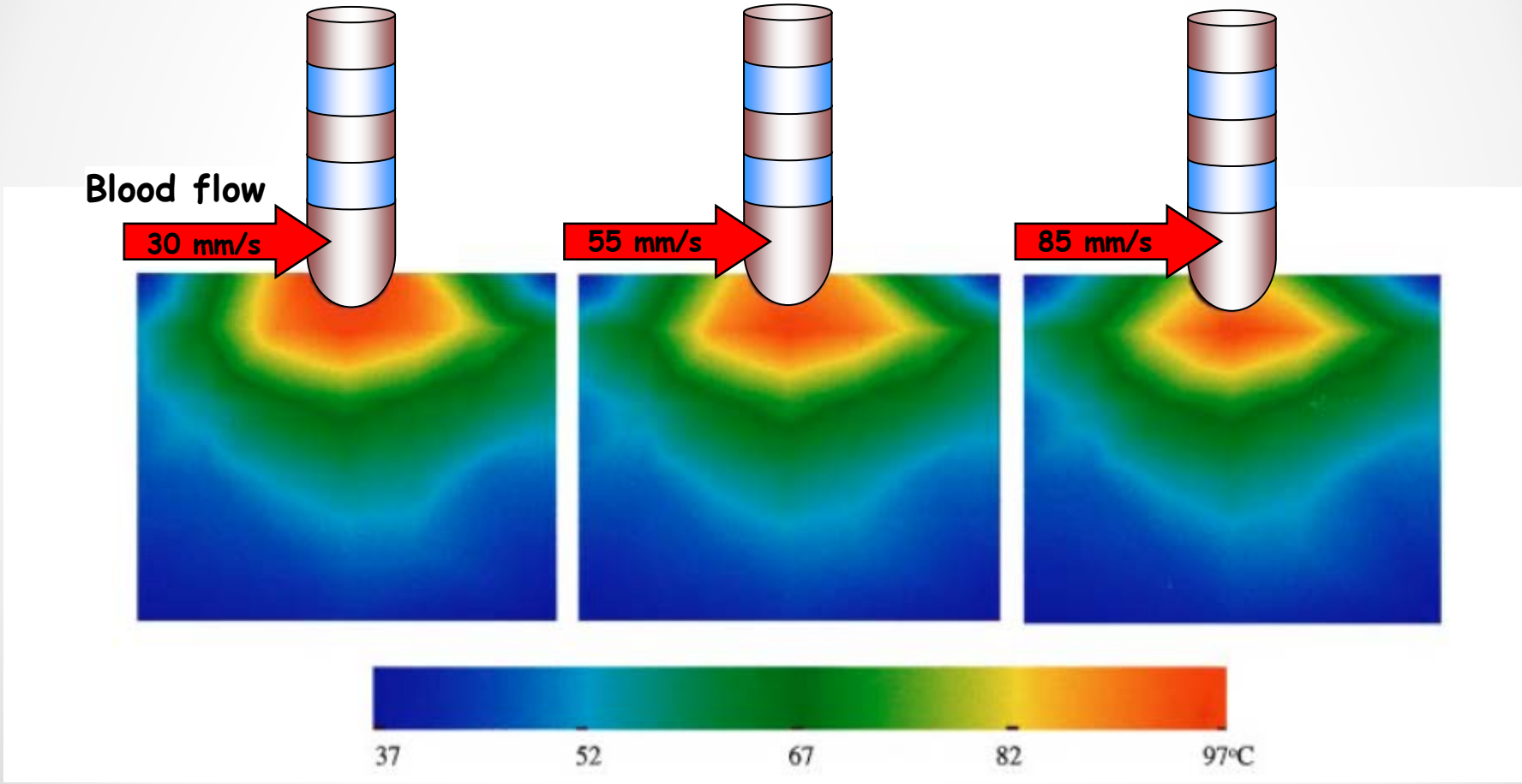


De Greef Y; Tavernier R; Schwagten B; De Keulenaer G; Stockman D; Duytschaever. Impact of Radio-Frequency Characteristics on Acute Pulmonary Vein Reconnection and Clinical Outcome after PVAC Ablation. *0007*. PACE, 2011; Vol 34: 1309-1310.

* Note: data shown is the average Temp & Power during ablation duration

Passive Cooling (mm/s)

change the Temperature profile

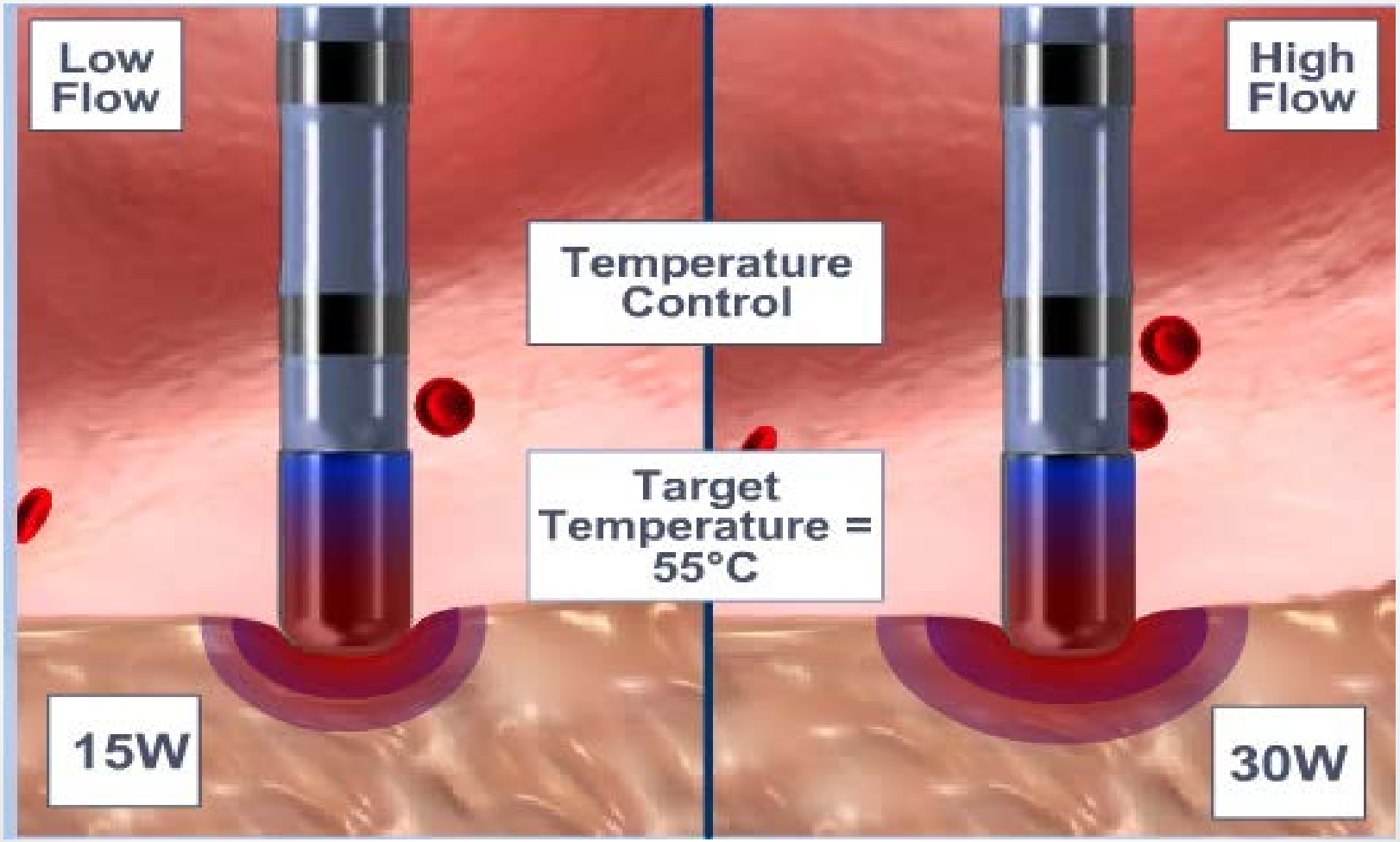


Natural Passive Cooling

Ann Biomed Eng 2000;28:1066

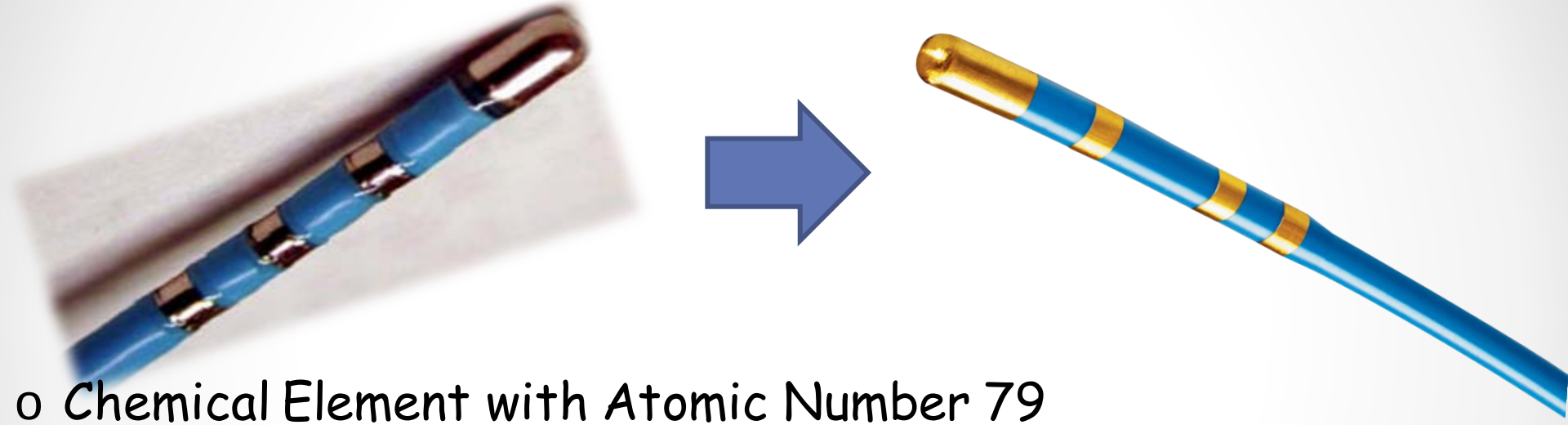
Passive Cooling (mm/s)

change the Force of Penetration



Ann Biomed Eng 2000;28:1066

Growing Interest for Alternative Procedure



- Chemical Element with Atomic Number 79
- Transition Element, Dense, Soft, Shiny, Malleable and Ductile metal
- Thermal conductivity (K): measure of a materials ability to conduct heat (W=J/sec)
  - Platinum = 71.6 W/m°C (70 W/m°K)
  - Gold = 317 W/m°C (260 W/m°K)
- Better temperature control across the electrode than Platinum

Comparison of Gold Versus Platinum Electrodes on Myocardial Lesion Size Using Radiofrequency Energy

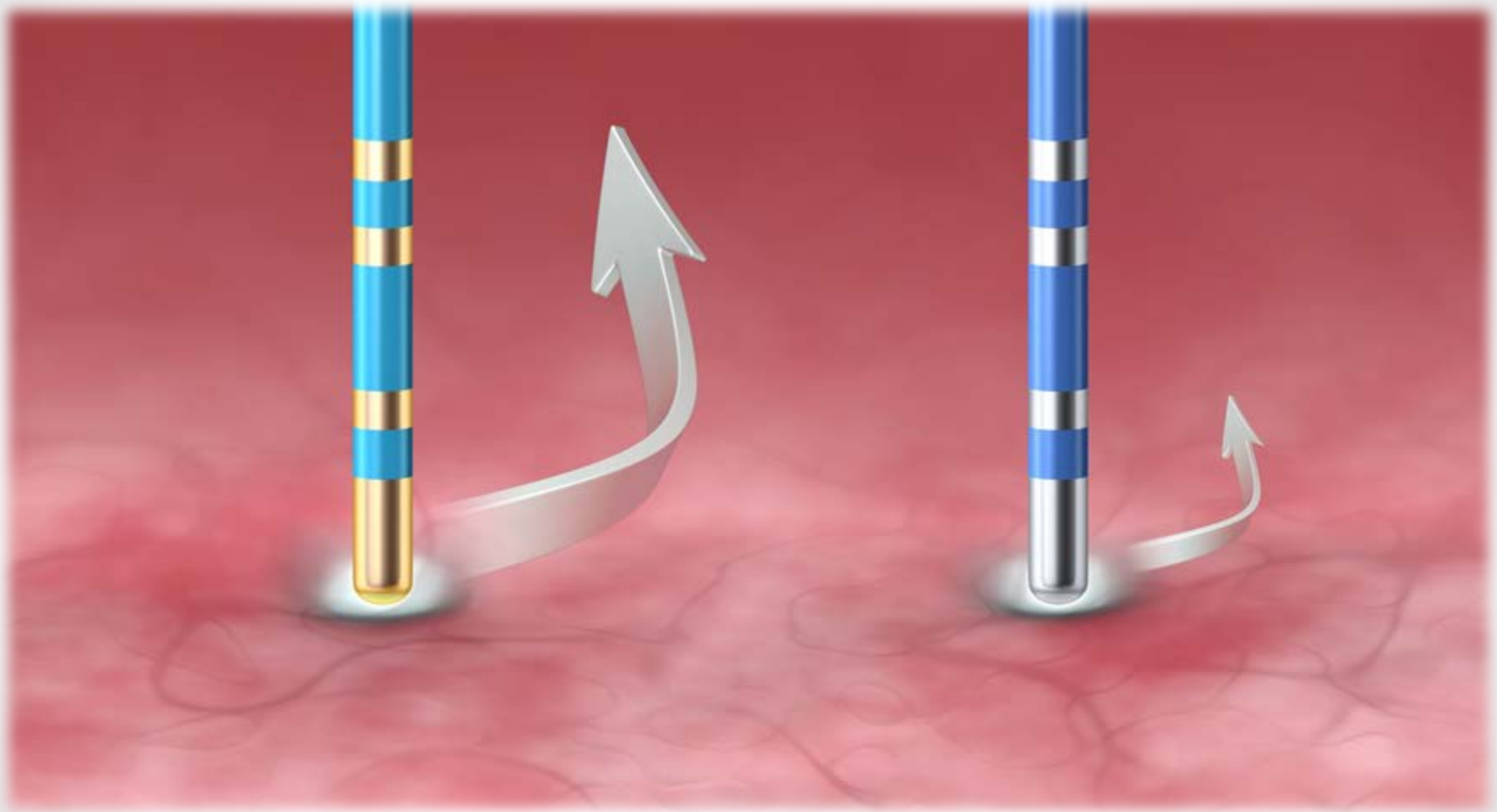
WALTER N. SIMMONS, SEAN MACKEY, DING SHENG HE, and FRANK I. MARCUS

From the Cardiology Section, Department of Medicine, and the Department of Electrical and Computer Engineering, University of Arizona, College of Medicine, Tucson, Arizona

(PACE 1996; 19[Pt. I]:398–402)

- Higher passive cooling of blood flow using Aurum
- Ability to drive more power
- Better efficacy in lesion's production
  (lesions volume greater than 30%)
- More uniform and deeper lesion
- Reduction of the risk of coagulum and steam-pops
- Faster creation of the lesions

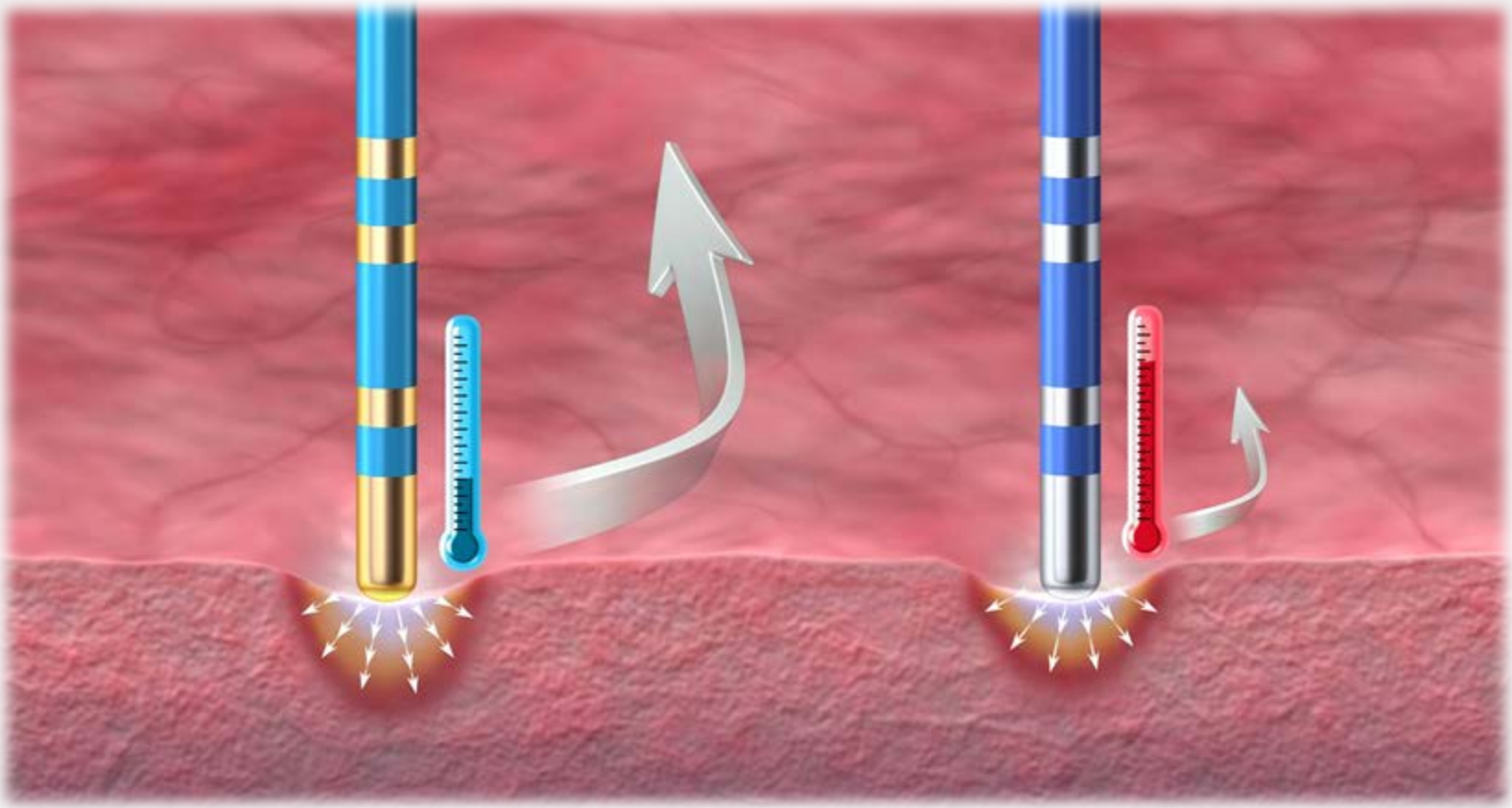
Alternative Option



Simmons et al.: Comparison of gold versus platinum electrodes on myocardial lesion size using radiofrequency energy. PACE '96.

Atsushi Ikeda et al.: Gold Radiofrequency Ablation Electrode Produces Deeper Lesions Without Increasing Risk of Thrombus, HRS '09.

New Catheters Generation

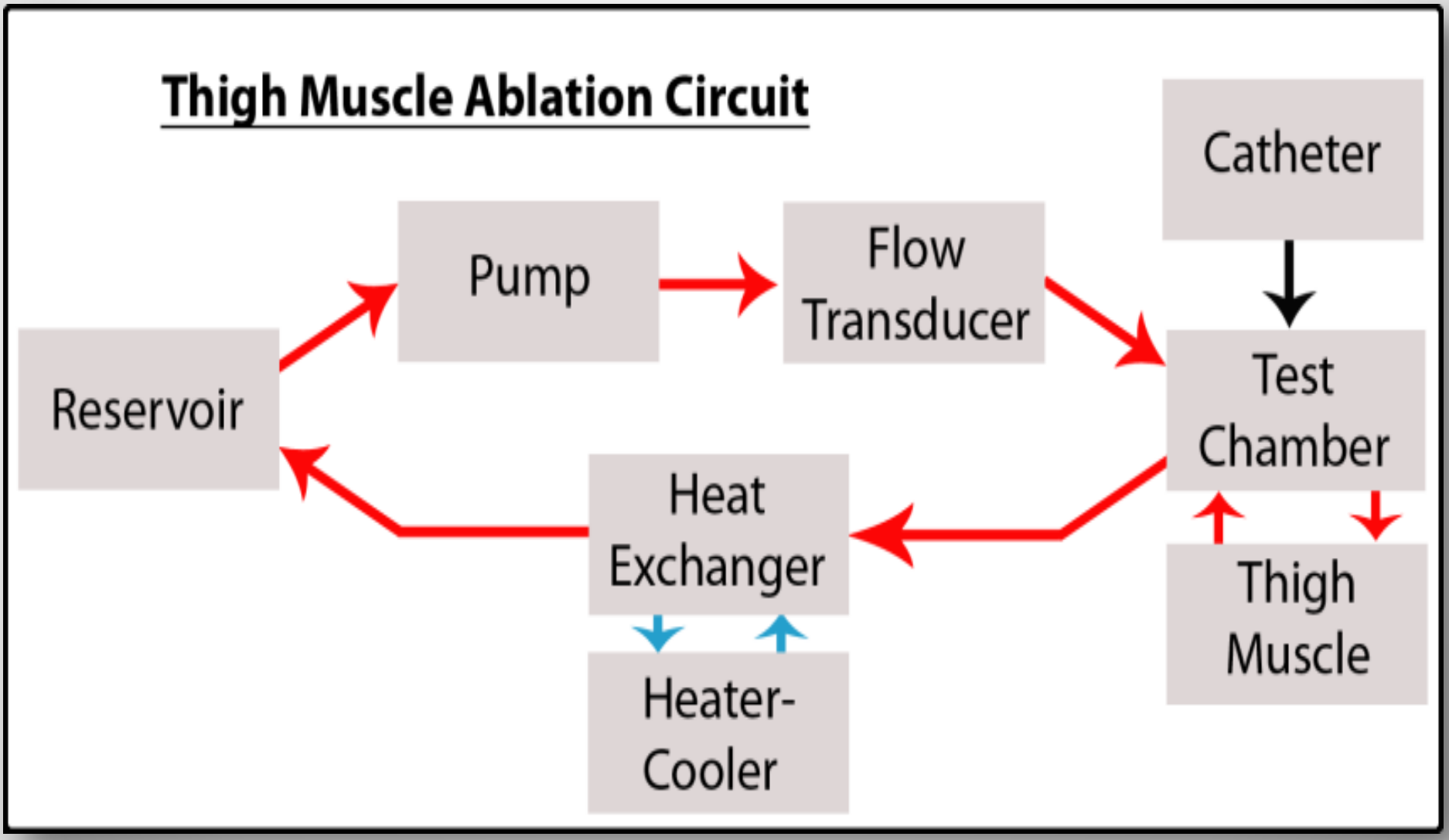


Lewalter et al.; Gold vs. platinum–iridium tip catheter for cavotricuspid isthmus ablation: the AURUM 8 study, Europace 2010.

Kardos et al.; Cavotricuspid Isthmus Ablation with Large-Tip Gold Alloy Versus Platinum-Iridium-Tip Electrode Catheters, PACE '09.

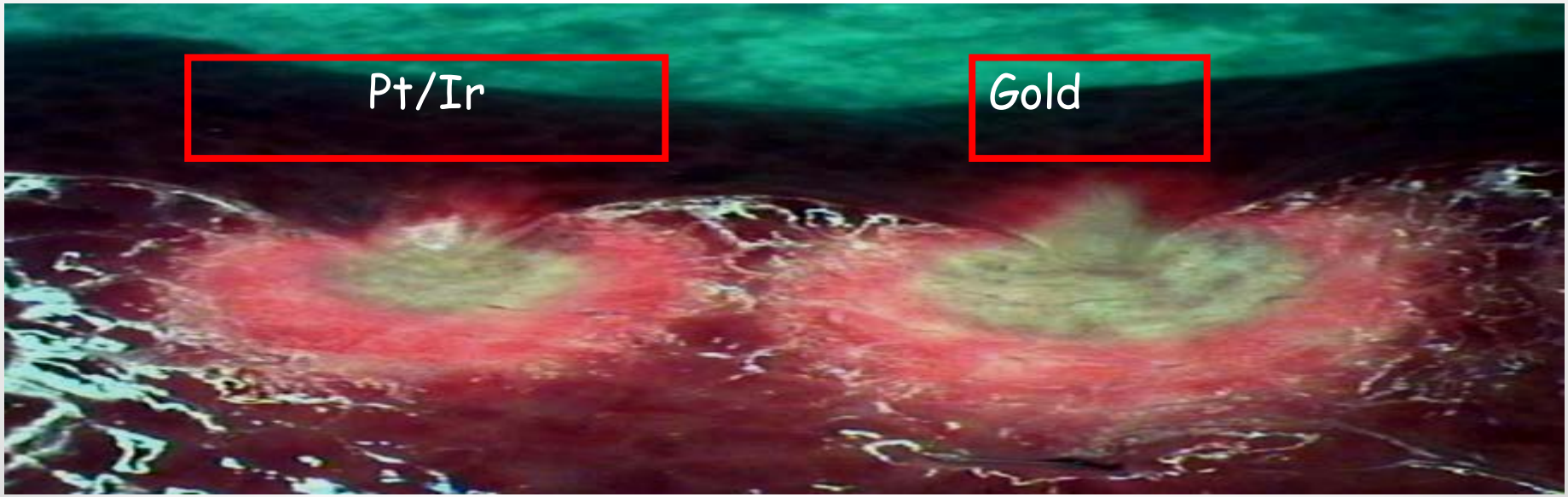
Linhardt et al.: In vitro comparison of platinum–iridium and gold tip electrodes: lesion depth in 4 mm, 8 mm, and irrigated-tip radiofrequency ablation catheters, Europace '09

In vitro tests (AlCath Au vs Pl)



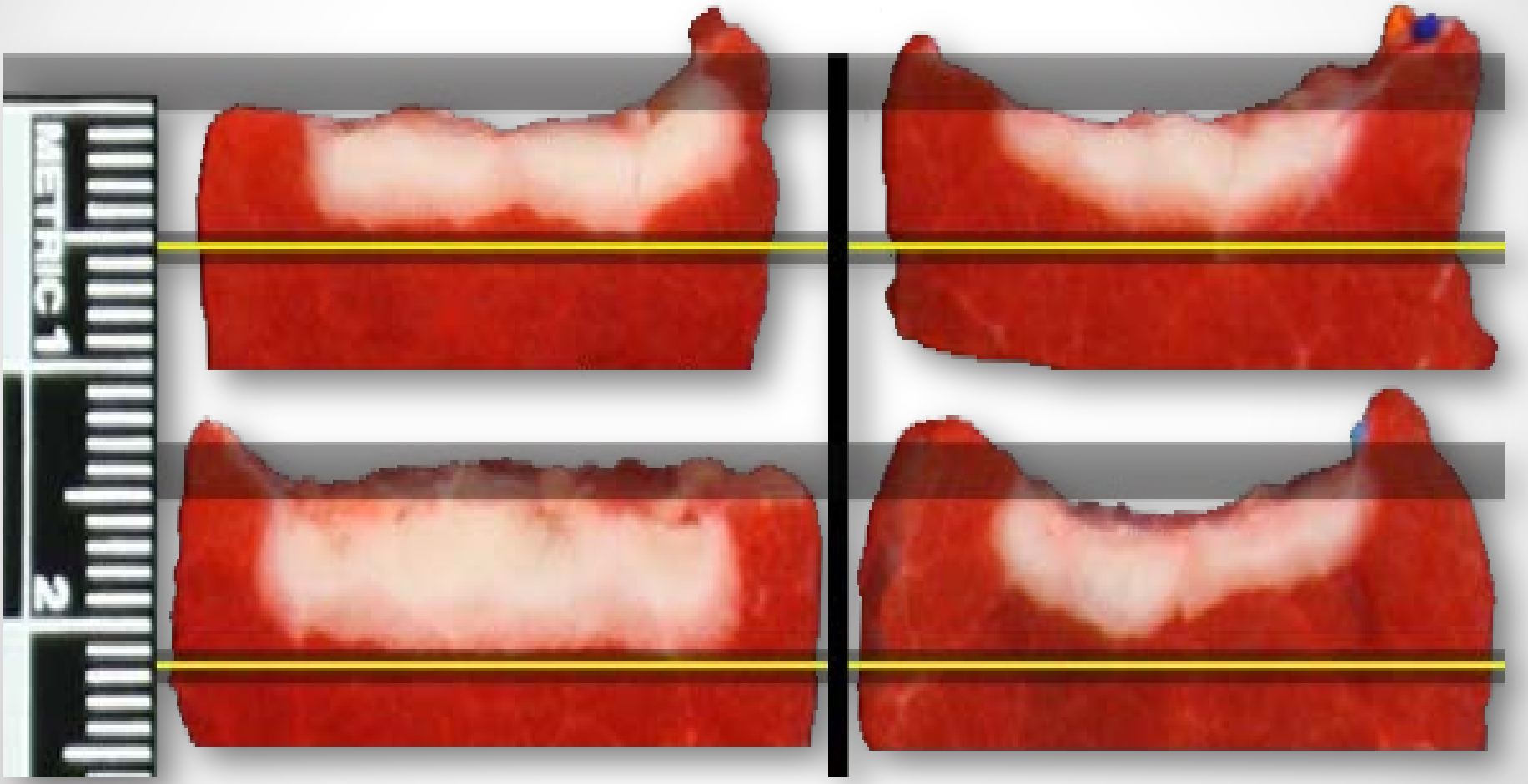
In vitro tests (AlCath Au vs Pl)

- In the Liver tissue, Gold allowed for 38% higher energy delivered and 35% deeper lesion respect to Platinum.
- In pig's Heart model, the energy difference was 112% and lesions 64% deeper.



Lewalter et al; Gold-Tip Electrodes - A New "Deep Lesion" Technology for Catheter Ablation? (JCE, Vol. 16, pp. 770-772, July '05)

In vitro tests (AlCath Au vs Pl)



Simmons et al.: Comparison of Gold Versus Pt/Ir electrodes on Myocardial Lesion Size Using Radiofrequency Energy (PACE '96 [Pt. I]:398-402)

How Aurum Does it Work

Greater Convective Cooling

In vivo canine thigh muscle	Gold 8mm n = 7	Standard 8mm n = 5	p
Mean power (W)	32.8 ± 2.3	22.0 ± 6.7	p<0,01
Interface temperature (°C)	62 ± 7	53 ± 6	p<0,05
Tissue temp. at 3mm (°C)	79 ± 11	65 ± 11	p<0,05
Tissue temp. at 7mm (°C)	53 ± 7	45 ± 7	n.s.
Lesion depth (mm)	7.2 ± 0.3	5.0 ± 1.0	p<0,01

Atsushi Ikeda et al, Gold Radiofrequency Ablation Electrode Produces Deeper Lesions Without Increasing Risk of Thrombus, HRS 2009, PO05-23.

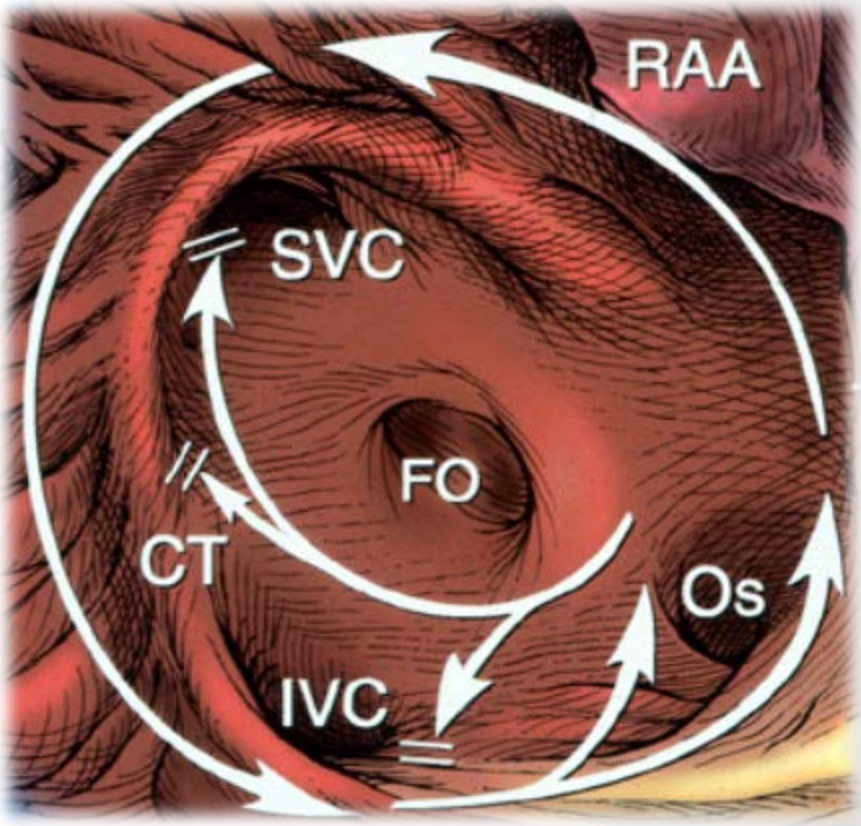
Perpendicular tip positioning, with 10g of contact force. RF current was delivered for 60 seconds with target electrode temperature at 48°C. At 2 hours after ablation and Lesion size was measured

How Aurum Does it Work

Greater Convective Cooling

- Sixty pts undergoing CTI ablation were randomized to one of the following Catheters:
  - 8-mm Aurum tip catheter
  - Externally irrigated-tip Cath
  - 8-mm Pt-tip Cath

- Gold-tip is slightly better than Pt-tip and equivalent to Irrigated tip catheter



Sacher et al: Prospective Randomized Comparison of 8-mm Gold-Tip, Externally Irrigated-Tip and 8-mm Platinum-Iridium Tip Catheters for Cavotricuspid Isthmus (CTI) Ablation (JCE, Vol.18, pp.709-713, Jul '07).

In vivo Clinical Studies

Efficacy in CTI ablation: Single Center Study

Single Center Study	Gold 8mm n = 15	Standard 8mm n = 16	p
Number of RF applications	4,6 ± 1,9	6,6 ± 3,1	p<0.001
Total RF delivery (sec)	280 ± 117	480 ± 310	p<0,001
Mean procedural time (min)	56,4 ± 12	73,1 ± 15	P=0.05
Fluoroscopy exposure (min)	4,9 ± 2,3	7,1 ± 3,8	p=0.01

Kardos et al.; Cavotricuspid Isthmus Ablation with Large-Tip Gold Alloy Versus Platinum-Iridium-Tip Electrode Catheters, PACE, Vol. 32 Supplement 1, March 2009, S. 138 – 140.

In vivo Clinical Studies

The AURUM 8 study – randomized, CTR and multicenter Trial

- Enrolled 463 pts with typical Afl
  - 236 pts (median 67.0 yrs, 19,4% female) randomized Au
  - 227 pts (median 66.5 yrs; 15,4% female) ranomized Pt/Ir
- Target Temperature was 60-70°C
  Max Power output was 60-75 Watts
- Lesion creation was compared between two different Cath.
  - (8-mm Au-tip vs 8-mm Pt/Ir-tip)
- Acute procedural success was validate using standard parameters (change of CTI activation sequence and differential pacing) and pts were FU for 6 mo (success and recurrences).

* Lewalter, abstract ESC 2008

Therapeutic Goals

The AURUM 8 study – randomized, CTR and multicenter Trial

- **Primary Endpoint**
  - Cumulative Duration of RF Energy Delivered

- **The Major Secondary endpoints**:
  - Acute success rate
  - Procedural duration
  - Time to first sign of unidirectional isthmus block
  - Char formation at the ablation electrode.

* Lewalter, abstract ESC 2008

In vivo Clinical Studies

The AURUM 8 study – randomized, CTR and multicenter Trial

Multicenter study AURUM 8	Gold 8mm n = 229	Standard 8mm n = 219	p
Mean power delivered (W)	52 ± 12	48 ± 13	p<0.001
Total ablation success rate	216 (94.3%)	195 (89.0%)	p<0,05
Isthmus block within 20 min	201 (91.7%)	176 (80.4%)	P=0.03
Isthmus block within 5 min	57 (24,9%)	35 (16.0%)	p=0.02

Lewalter et al.; Gold vs. platinum–iridium tip catheter for cavotricuspid isthmus ablation: the AURUM 8 study, Europace 2010, doi:10.1093/europace/euq339.

In vivo Clinical Studies

The AURUM 8 study – randomized, CTR and multicenter Trial

- A trend toward **shorter median cumulative duration of energy delivery** for Au vs. Pt/Ir was observed, even if it did not reach a statistical significance (486 vs. 522 s, p=0.25)
- **The acute effective success rate** was significantly higher in Aurum group than Pt/Ir group (93,3% vs 89,0%, p<0,05)
- The Au-tip Cath was associated with a **significant reduction of char and thrombus formation** (p<0.0001)

* Lewalter, abstract ESC 2008

The "GOLDART" studies

Prospective, randomized and multicenter study (252 pts)

- Comparison between **AlCath Pt/Ir-tip vs Gold-tip** during RFCA of AVNRT
- A **trend towards higher power delivery** in the Au group was observed even if it was not statistically significant
- **Gold-tip Catheter had less blood coagulation**, because charring-on the Catheter-tip after the intervention was observed eight-fold more frequently in the Pt/Ir group

Stuhlinger et al: Gold Alloy Versus Pl/Ir Electrode for Ablation of AVNRT (GOLDART). JCE Oct '07 (online early articles).

Therapeutic Goals

Prospective, randomized and multicenter study (252 pts)

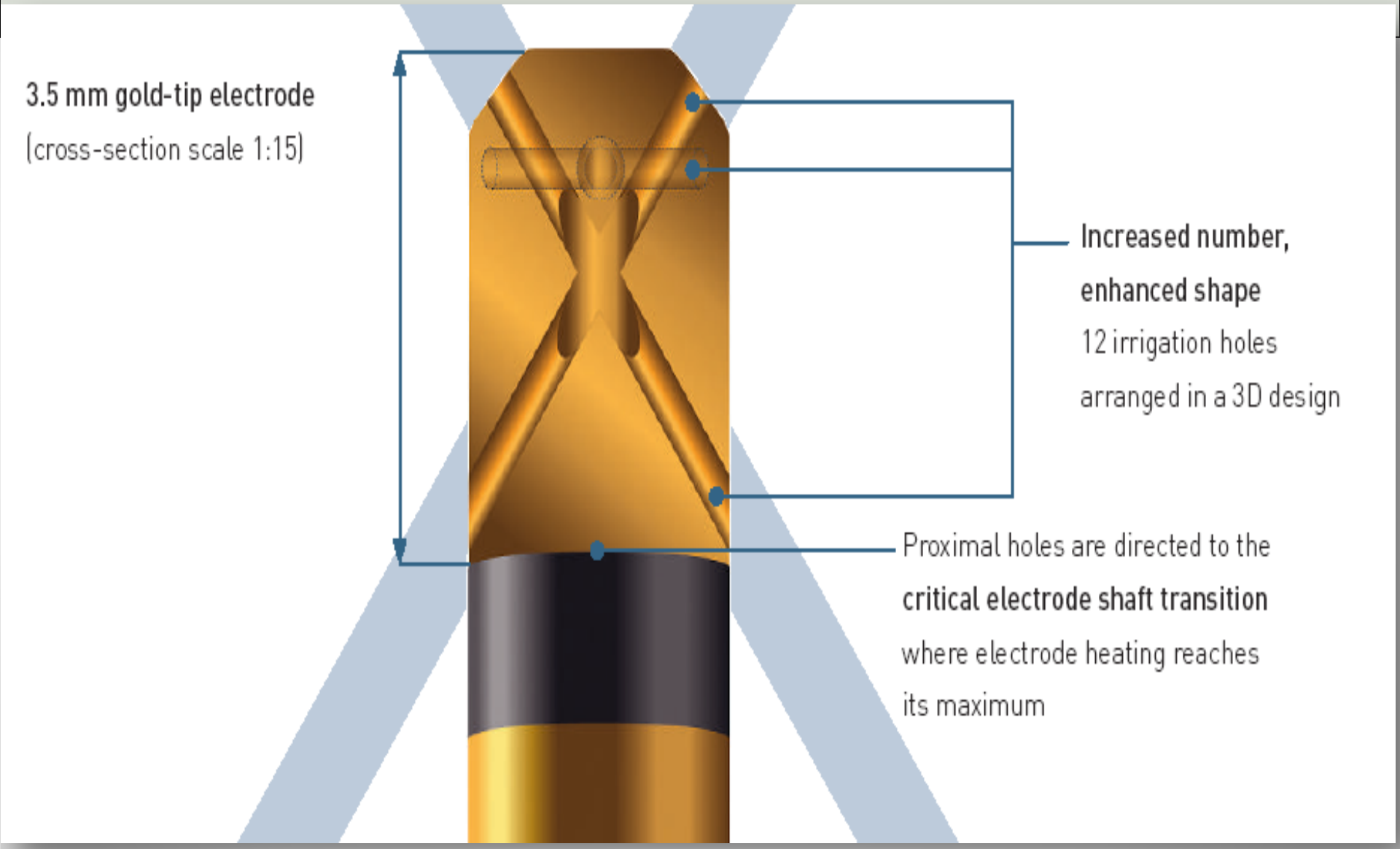
Procedure Related Adverse Events and Complications in GOLDART

	Pt–Ir tip (n = 124)	Gold tip (n = 128)	P-value
AV-conduction block (%)	3 (2.4)	4 (3.2)	n.s.
Transient AV-block (%)	0 (0)	1 (0.8)	n.s.
Permanent AV-block (%)	3 (2.4)	3 (2.4)	n.s.
AV-block I (%)	0 (0.0)	0 (0.0)	n.s.
AV-block II (%)	1 (0.8)	1 (0.8)	n.s.
AV-block III (%)	2 (1.6)	2 (1.6)	n.s.
Charring/clotting (%)	8 (6.4)	1 (0.8)	<0.05
Pain during ablation (%)	47 (37.9)	41 (33.1)	n.s.
Mild pain (%)	31 (25.0)	29 (23.4)	n.s.
Moderate/severe pain (%)	16 (12.9)	12 (9.6)	n.s.

AV-block = atrioventricular block.

Stuhlinger et al: Gold Alloy Versus Pl/Ir Electrode for Ablation of AVNRT (GOLDART). JCE Oct '07 (online early articles).

AlCath Flux eXtra Gold



AlCath Flux eXtra Gold

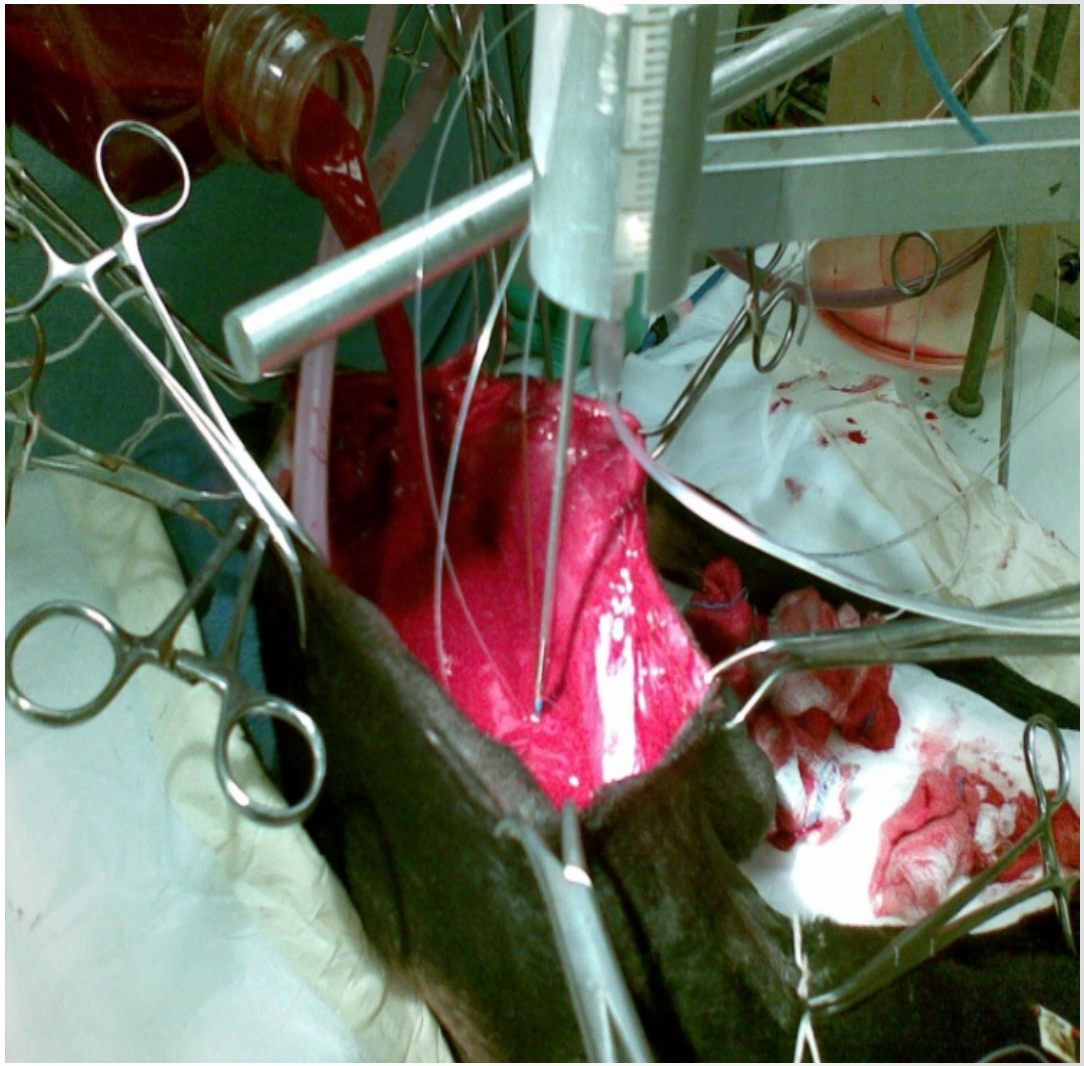
Flow Rate:

- Slow Flow: mapping process 2 ml/min
- High Flow: ablation
  - 30 ml/min VT ablation or Power >30W
  - 17 ml/min LA ablation or Power <30W

- Anatomically design (X shape) for higher, more uniform and better cooling at the tip surface (33%)

In vivo Clinical Studies

- RFCA using **AlCath Gold, Gold Flux** and **Pt** with temp and Power CTR modality in a dogs model ("tight muscle")
- The surface area was irrigated using blood heparinized (37°C and 0.5 m/sec).
- The tip of the Cath was placed with a contact force of 10 gr and RF was released for 60" (simulation).



* Nakagawa et al., Abstract HRS May 2009

In vivo Clinical Studies

Electrode Length, Orientation	Electrode Material	Electrode Temp (°C)	n	Power (W)	Interface Temp (°C)	Tissue Temp (°C)		Lesion Depth (mm)	Thrombus Formation
						3mm	7mm		
4mm Perpendicular	Gold	55	7	13.6±5.0*	55±5	71±12*	49±6*	5.9±1.2**	0/7
	Platinum	55	7	7.6±2.3	59±6	55±6	41±4	3.8±0.6	0/7
8mm Perpendicular	Gold	48	7	32.8±2.3**	62±7*	79±11*	53±7	7.2±0.3**	0/7
	Platinum	48	5	22.0±6.7	53±6	65±11	45±7	5.0±1.0	0/5

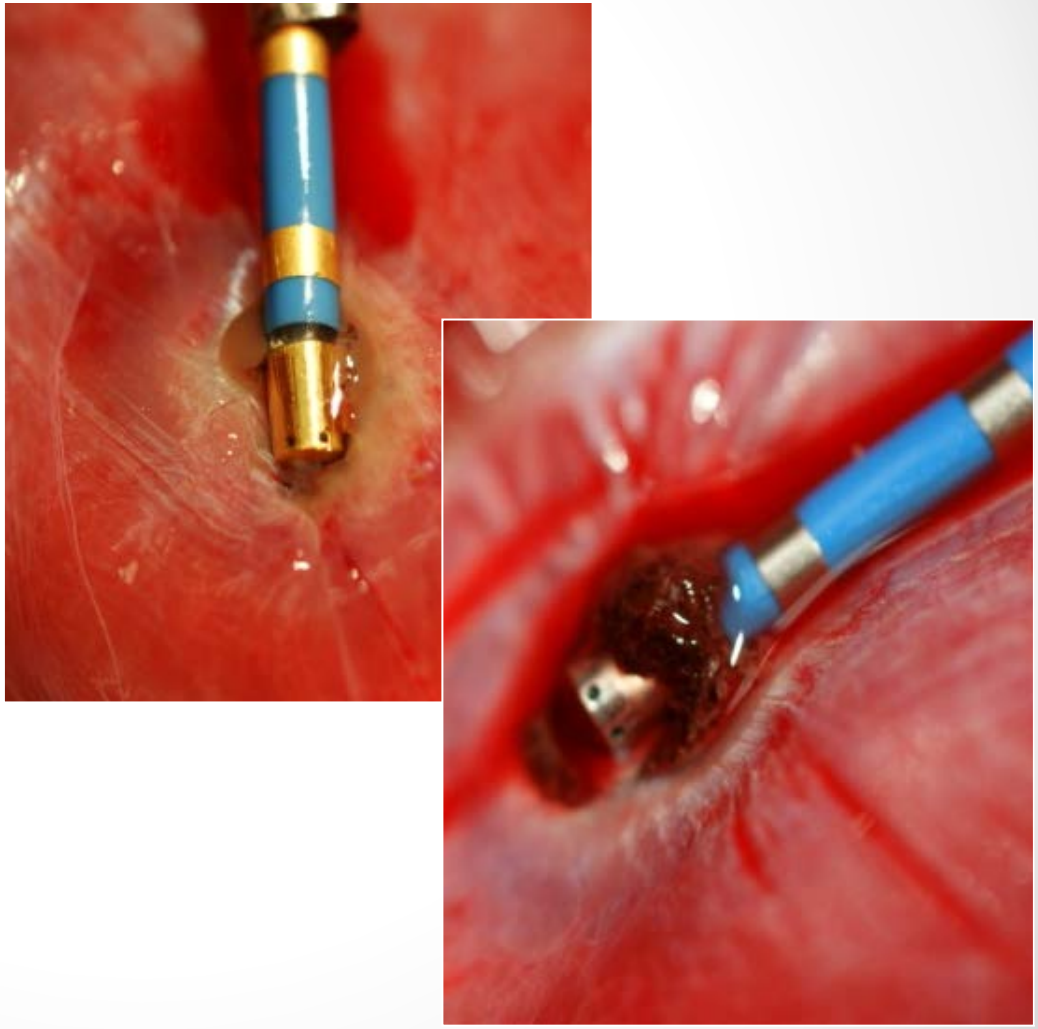
* Nakagawa et al., Abstract HRS May 2009

(*P<0.05, **P<0.01)

In vivo Clinical Studies

Irrigated RF ablation catheters

- Gold provides **greater convective cooling** resulting in **greater RF power delivery and deeper RF lesions** (>40%) w/o increasing the risk of thrombus formation" (perpendicular)



Ikeda, H. Nakagawa, J. V Pitha, T. Sharma, R. Lazzara, K.-H. Kuck, W. Jackman: Gold RF Ablation Electrode Produces Deeper Lesions Without Increasing Risk of Thrombus, HRS '09.

In vivo Clinical Studies

Irrigated RF ablation catheters

RF Power		Electrode		Electrode Temp.	Interface Temp.	Tissue Temperature ℃		Lesion Depth	Thrombus
W	Orientation	Material	n	℃	℃	3 mm	7 mm	mm	Incidence
30	Perpendicular	Gold	9	35.6 ± 5.2*	53 ± 11	90 ± 7	52 ± 6	8.0 ± 0.3	0/9
		Platinum	9	42.6 ± 4.6	62 ± 16	97 ± 17	56 ± 12	7.9 ± 0.3	0/9
	Parallel	Gold	11	40.5 ± 3.2*	60 ± 15	85 ± 14	54 ± 12	7.8 ± 0.3	4/11*
		Platinum	11	56.8 ± 5.2	67 ± 14	94 ± 13	61 ± 10	7.7 ± 0.5	11/11

*$p<0.05$, **$p<0.01$ comparison between gold and platinum

- Gold Flux vs. Plt Flux, In Vivo.
- „Compared to Plt, Gold electrode reduced the incidence of thrombus >2,5 times higher with parallel orientation

* Nakagawa oral presentation at HRS Satellite Symposium 2009

Gold Tip Ablation Catheter Preclinical and Clinical Evidence

In vitro study	Nakagawa	GOLDART	AURUM 8	Case Study
liver + pig heart AC G	dog thigh muscle AC G + AC Flux G	AVNRT AC G	A-Flutter AC LT G	WPW AC LT G
Primary Endpoint: Significance in lesion depth with gold catheters	**Primary Endpoint:** AlCath Flux G reduced the incidence of thrombus AlCath G Provides greater convective cooling, resulting in greater RF power delivery and deeper RF lesions without increasing risk of thrombus	**Primary Endpoint:** no significant increase in power delivery through gold catheters	**Primary Endpoint:** did not demonstrate significant change in duration of energy application	**Primary Endpoint:** ablation resulted in loss of anterograde conduction in the pathway
Significant Advantages: Liver tissue (in vitro) - 35.3% deeper lesions - 38.7% higher power delivery at the same temperature level Pig heart (in vitro) - 63.9% deeper lesions - 112% higher power delivery at the same temperature level	**Significant Advantages:** AlCath Flux G - significantly lower electrode temperature - lower incidence of thrombus formation AlCath G - higher RF power delivery - greater tissue temperatures - deeper RF lesions - no increase in risk of thrombus formation	**Significant Advantages:** - 8 times less charring than with Pt/Ir catheters - significant reduction of coagulum formation - specifically no increased risk of AV-block	**Significant Advantages:** - significantly higher acute procedural success rate - significant reduction of thrombus and char formation - trend toward short median cumulative duration of energy	**Significant Advantages:** - achieving an ablation result that could not be achieved with conventional catheters - no recurrence after 18 month follow-up

Conclusions

- **What Benefits Does Gold Offer?**
  - Thermal conductivity = measure of a materials ability to conduct heat
    - Platinum = 71.6 W/m°C
    - Gold = 317 W/m°C

  Create more consistent lesions independent of cardiac flow conditions

  - Better temperature control across the electrode
  - Ability to drive more power
  - Create deeper lesions
  - Deeper lesions and more power in low flow condictions
  - More consistent power delivery